Units of measurement

2

syllabus reference

Measurement 1

- **Units of measurement**

In this chapter

Are you ready?

Try the questions below. If you have difficulty with any of them, extra help can be obtained by completing the matching SkillSHEET. Either click on the SkillSHEET icon next to the question on the *Maths Quest Preliminary Course* CD-ROM or ask your teacher for a copy.

Conversion of units

1 Complete each of the following conversions.

a 5 m = ___ cm **b** 6.2 km = ___ m **c** 8500 mm = ___ m
d 2000 g = ___ kg **e** 6.25 t = ___ kg **f** 750 mL = ___ L

Converting units of time

2 Complete each of the following conversions.

a 48 hours = ___ days **b** 4 years = ___ weeks **c** 8 hours = ___ min

Writing one quantity as a percentage of another

3 In each of the following write the first quantity as a percentage of the second. Give your answers correct to 1 decimal place.

a 1 cm; 2 m **b** 0.5 m; 15 m **c** 5 min; 9 hours

Rounding to a given number of decimal places

4 Round each of the following correct to the number of decimal places indicated in the brackets.

a 2.186 486 [4] **b** 0.001 563 4 [3]
c 48.8094 [2] **d** 118.3468 [1]

Increase or decrease by a percentage

5 Calculate the following.

a $750 increased by 12% **b** $2500 decreased by 5%
c 3 kg increased by 7.5% **d** 1.25 L decreased by 12.5%

Simplifying ratios

6 Simplify each of the following ratios.

a 48 : 20 **b** 1.5 m : 45 cm **c** 0.2 : 0.65 **d** $\frac{1}{4} : \frac{1}{6}$

Units of measurement

We deal with measurement every day of our lives. Each time we pick up a ruler, look at our watch, or purchase a can of drink from the school canteen we are using measurement. The quantities measured most often are length, mass, capacity and time. The units used are the basis for the more complicated measurements of area and volume.

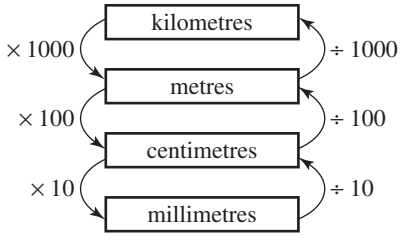
The system we use for measurement is the International System of Units (SI system), more commonly known as the metric system. This system was introduced in Australia in 1972 to replace the 'Imperial' system. The metric system is simpler to use because it is based on **powers** of 10. Units of measurement can be compared under the metric system by examining the **prefix**.

Units of length

Units of length are based on the *metre*. There are four units commonly used for measuring length: the millimetre (mm), centimetre (cm), metre (m) and kilometre (km).

10 millimetres = 1 centimetre
100 centimetres = 1 metre
1000 metres = 1 kilometre

The flow chart at right shows how to convert units of measurement.



WORKED Example 1

Complete each of the following.
a 30 mm = ____ cm **b** 4800 m = ____ km **c** 6.5 m = ____ cm **d** 8400 mm = ____ m

THINK

a Changing millimetres to centimetres: divide by 10.
b To change metres to kilometres: divide by 1000.
c To change metres to centimetres: multiply by 100.
d To change millimetres to metres: divide by 10 (to change to centimetres) then divide by 100 (to change to metres).

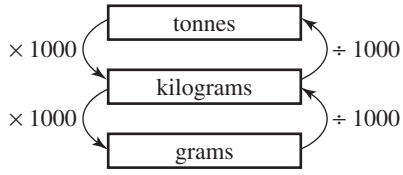
WRITE

a 30 mm = 30 ÷ 10 cm
= 3 cm
b 4800 m = 4800 ÷ 1000 km
= 4.8 km
c 6.5 m = 6.5 × 100 cm
= 650 cm
d 8400 mm = 8400 ÷ 10 cm
= 840 ÷ 100 m
= 8.4 m

Units of mass

The same method can be used to convert units of mass. There are three main units of mass: the gram (g), kilogram (kg) and tonne (t).

1000 grams = 1 kilogram
1000 kilograms = 1 tonne



Remembering these conversions can be aided by a flow chart.

WORKED Example 2

Complete the following.
a 4000 g = ____ kg **b** 9750 kg = ____ t **c** 3.2 kg = ____ g **d** 0.65 t = ____ kg

THINK

a To change grams to kilograms: divide by 1000.
b To change kilograms to tonnes: divide by 1000.
c To change kilograms to grams: multiply by 1000.
d To change tonnes to kilograms: multiply by 1000.

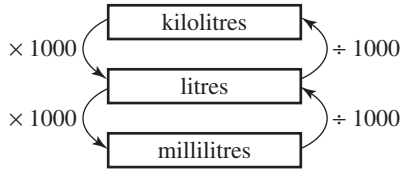
WRITE

a 4000 g = 4000 ÷ 1000 kg
= 4 kg
b 9750 kg = 9750 ÷ 1000 t
= 9.75 t
c 3.2 kg = 3.2 × 1000 g
= 3200 g
d 0.65 t = 0.65 × 1000 kg
= 650 kg

Units of capacity

Capacity is the measure of liquid volume. The three common units used to measure capacity are: millilitres (mL), litres (L) and kilolitres (kL).

1000 millilitres = 1 litre
1000 litres = 1 kilolitre



The flow chart for converting these units is similar to that for mass.

WORKED Example 3

Complete the following.
a 6000 mL = ____ L **b** 2500 L = ____ kL **c** 0.8 L = ____ mL **d** 10.5 kL = ____ L

THINK

a To change millilitres to litres: divide by 1000.
b To change litres to kilolitres: divide by 1000.
c To change litres to millilitres: multiply by 1000.
d To change kilolitres to litres: multiply by 1000.

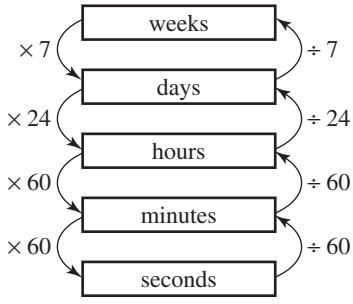
WRITE

a 6000 mL = 6000 ÷ 1000 L
= 6 L
b 2500 L = 2500 ÷ 1000 kL
= 2.5 kL
c 0.8 L = 0.8 × 1000 mL
= 800 mL
d 10.5 kL = 10.5 × 1000 L
= 10 500 L

Units of time

We use a more complicated system of units for time, but as we are so familiar with time, this is not difficult.

60 seconds (s) = 1 minute (min)
60 minutes = 1 hour (h)
24 hours = 1 day
7 days = 1 week



In each of the measures of time shown, the conversions are straightforward. There are, however, others which are not so precise. For example, there are 365 days in one year, except in a leap year when there are 366. We also say that there are 52 weeks in a year. However, there are actually 52 weeks and either 1 or 2 days. Finally, there are always 12 months in a year but the number of days in each month varies.

WORKED Example 4

Complete the following.

a 3 min = ____ s **b** 300 min = ____ h **c** 4 days = ____ h
d 1 day = ____ min **e** 2 h = ____ s

THINK	WRITE
a To change minutes to seconds: multiply by 60.	**a** 3 min = 3 × 60 s = 180 s
b To change minutes to hours: divide by 60.	**b** 300 min = 300 ÷ 60 h = 5 h
c To change days to hours: multiply by 24.	**c** 4 days = 4 × 24 h = 96 h
d To change days to minutes: multiply by 24 (to change to hours) then multiply by 60 (to change to minutes).	**d** 1 day = 1 × 24 h = 24 × 60 min = 1440 min
e To change hours to seconds: multiply by 60 (to change to minutes) then multiply by 60 (to change to seconds).	**e** 2 hours = 2 × 60 min = 120 × 60 s = 7200 s

When making a measurement it is important to first determine the kind of quantity you are measuring (length, mass, capacity or time) and then to choose the most practical unit. For example, to measure the diameter of a coin you would use length and the most practical unit would be millimetres.

WORKED Example 5

Choose the most appropriate unit for each of the following measurements.

a The thickness of a book
b The amount of water in a glass
c The amount of matter in a cricket ball
d The length of a movie

THINK

a The thickness of a book is a measure of length.
b The amount of water in a glass is a measure of capacity.
c The amount of matter in a cricket ball is a measure of mass.
d The length of a movie is a measure of time.

WRITE

a Millimetres is the most practical unit to use.
b Millilitres is the most practical unit to use.
c Grams is the most practical unit to use.
d Minutes is the most practical unit to use.

remember

1. Remember the unit conversions for length, mass, capacity and time.
2. When changing from a smaller unit to a larger unit, complete the conversion by dividing. (For example, 3 min = 3 ÷ 60 h = 0.05 h.)
3. When changing from a larger unit to a smaller unit, complete the conversion by multiplying. (For example, 2.5 t = 2.5 × 1000 kg = 2500 kg.)
4. Choose the most appropriate unit for a measurement by choosing the type of measurement, then the most practical unit.

EXERCISE 2A Units of measurement

SkillSHEET 2.1 Conversion of units

WORKED Example 1

1 Copy and complete each of the following.

a 70 mm = ____ cm
b 600 cm = ____ m
c 5000 m = ____ km
d 9 cm = ____ mm
e 12 m = ____ cm
f 9 km = ____ m
g 86 mm = ____ cm
h 9.2 km = ____ m
i 2400 m = ____ km
j 6.4 cm = ____ mm
k 11.25 m = ____ cm
l 2.2 cm = ____ mm

SkillSHEET 2.2 Converting units of time

WORKED Example 2

2 Copy and complete the following.

a 8000 g = ____ kg
b 3000 kg = ____ t
c 7 t = ____ kg
d 5 kg = ____ g
e 9500 kg = ____ t
f 2350 g = ____ kg
g 5.5 t = ____ kg
h 4.84 kg = ____ g

EXCEL Spreadsheet Converting metric units

WORKED Example 3

3 Copy and complete the following.

a 2000 mL = ____ L
b 11 000 L = ____ kL
c 4 kL = ____ L
d 15 L = ____ mL
e 4800 L = ____ kL
f 8650 mL = ____ L
g 7.9 kL = ____ L
h 12.8 L = ____ mL

WORKED Example 4

4 Copy and complete the following.

a 240 s = ____ min	**b** 360 min = ____ h	**c** 72 h = ____ days
d 5 days = ____ h	**e** 7 h = ____ min	**f** 3 h = ____ min
g 2 years = ____ days	**h** 3 years = ____ months	**i** 4 years = ____ weeks
j 36 h = ____ days	**k** 1 week = ____ h	**l** 450 min = ____ h

5 Richard is planning to have a garage built. The garage is 5.2 m long, 2.4 m wide and 2.5 m high. All builders, however, work in millimetres. What are the dimensions of the garage, in millimetres?

6 Peter is a truck driver. When he is passing through a small country town a detour takes him to a road that has a 4 tonne weight limit on all vehicles. Peter's truck, including its load, is 3850 kg. How many kilograms under the weight limit is the truck?

7 A factory is producing orange juice. One kilogram of oranges will produce 400 mL of freshly squeezed juice. How many litres of orange juice can be produced from 4.5 tonnes of oranges?

8 At a car sales yard there are 1200 cars. It takes 20 minutes for a person to detail a car. If 15 people are employed to detail cars, how many hours will it take for all cars to be detailed?

9 **multiple choice**

One litre of water has a mass of 1 kg. What would be the mass of 1 mL of water?

A 1 g **B** 10 g **C** 100 g **D** unknown

10 **multiple choice**

The number of millimetres in 2.4 km is:

A 24 000 **B** 240 000 **C** 2 400 000 **D** 24 000 000

WORKED Example 5

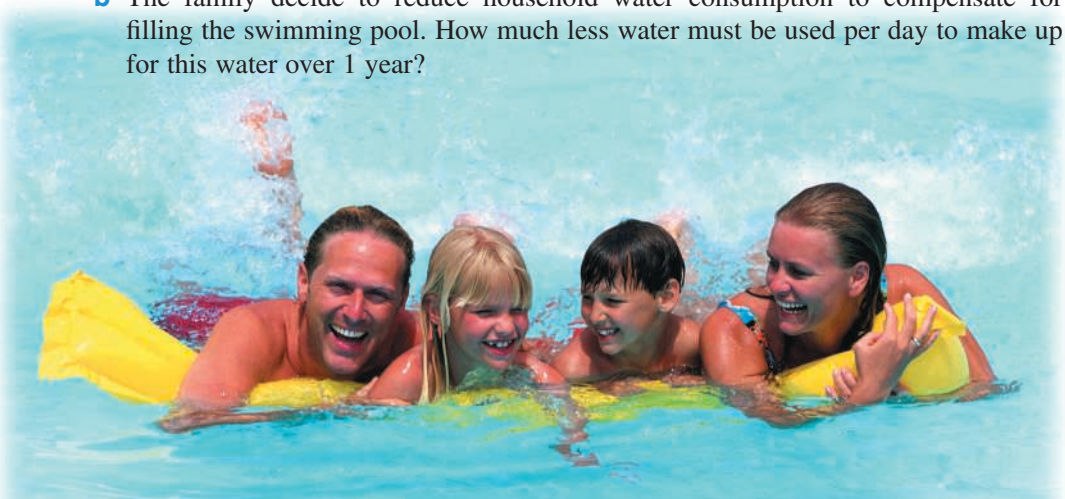
11 Choose the appropriate unit for each of the following measurements.

a The time taken to run 100 metres
b The amount of petrol in a car's petrol tank
c A person's height
d The distance between two cities
e The mass of a truck

12 The Schneider family purchase a backyard swimming pool.

a Copy and complete the following statement using the appropriate unit of capacity.
The amount of water used to fill the pool would be 150 _____.

b The family decide to reduce household water consumption to compensate for filling the swimming pool. How much less water must be used per day to make up for this water over 1 year?



Relative error

How far is it from your house to school? If you live very close to school you may give your answer in metres, or if you are a bit further away you would probably answer in kilometres. In either case the answer you give would not be exact. In fact, no measurement is exact. We are able to measure a quantity only to the degree of accuracy that our instruments allow.

All measurements are approximations.

In practice, we usually choose a degree of accuracy that is convenient. For example, you may say that it is 4 km from your home to school. In this case, the measurement would be given to the nearest kilometre. The actual distance from your home to school could be anything between 3.5 km and 4.5 km.

Someone who lives close to school may say it is 600 m to school. This measurement is probably given to the nearest 100 m. The actual distance would be between 550 m and 650 m.

When rounding off measurements, the maximum error possible is half the degree of accuracy stated.

WORKED Example 6

Hilary has her height measured at 164 cm. This measurement is given to the nearest centimetre. Between what values would her actual height be?

THINK

1. The maximum error is half the degree of accuracy used (1 cm).
2. Subtract 0.5 cm from 164 cm to find the smallest possible measurement.
3. Add 0.5 cm to find the largest possible measurement.
4. Give a written answer.

WRITE

Maximum error = 0.5 cm

Lower limit = 164 – 0.5
= 163.5 cm
Upper limit = 164 + 0.5
= 164.5 cm

Hilary's height is between 163.5 cm and 164.5 cm.

WORKED Example 7

The mass of a trailer load of soil is given as 260 kg. The mass is given to the nearest 10 kg. Between what two masses would the true mass of the trailer load actually be?

THINK

1. The maximum error is half the degree of accuracy used (10 kg).
2. Subtract 5 kg from 260 kg to find the smallest possible measurement.
3. Add 5 kg to 260 kg to find the largest possible measurement.
4. Give a written answer.

WRITE

Maximum error = 5 kg

Lower limit = 260 – 5
= 255 kg
Upper limit = 260 + 5
= 265 kg

The soil's mass is between 255 kg and 265 kg.

The true degree of accuracy in a measurement is found by determining the maximum **percentage error**. To do this we find the greatest possible error and then write that as a percentage of the measurement given.

$$\text{Percentage error} = \frac{\text{maximum error}}{\text{measurement}} \times 100\%$$

WORKED Example 8

A car's fuel tank has a capacity of 65 litres. If this capacity is given to the nearest litre, find the degree of accuracy as a percentage (answer correct to 2 decimal places).

THINK	WRITE
1 Find the maximum error. This is half the degree of accuracy used (1 L).	Maximum error = 0.5 L
2 Write the percentage error rule.	Percentage error = $\frac{0.5}{65} \times 100\%$
3 Calculate the percentage error to 2 decimal places.	= 0.77%
4 Give a written answer.	The degree of accuracy is 0.77%.

The degree of accuracy as a percentage shows how accurate a measurement is.

No measuring instrument is perfect and different people can sometimes obtain a different reading from the same instrument. For example, one person may measure a person's height as 162 cm while another may get an answer of 163 cm. To reduce the likelihood of error, we can average several readings of the same measurement.

WORKED Example 9

Taylor has her height measured by 8 people. They obtain the following results:
169 cm, 169 cm, 168 cm, 170 cm, 169 cm, 169 cm, 168 cm, 168 cm.
What is the average result?

THINK	WRITE
1 Find the total of the 8 readings.	Total = 169 + 169 + 168 + 170 + 169 + 169 + 168 + 168
	= 1350
2 Divide the total by 8 to find the average.	Average = 1350 ÷ 8
	= 168.75 cm

remember

1. All measurements are approximations that are limited by the accuracy of the measuring instrument.
2. The maximum error of any measurement is half the degree of accuracy used.
3. The true accuracy of a measurement is found by calculating the percentage error. This is the maximum error as a percentage of the measured reading.
4. To obtain a more accurate measurement, several readings can be averaged.

EXERCISE 2B Relative error

WORKED Example 6

1 Each of the following measurements are given to the nearest centimetre. State the limits between which the true length lies.

a 5 cm **b** 12 cm **c** 34 cm
d 59 cm **e** 90 cm **f** 2 m

SKILLSHEET 2.3 Writing one quantity as a percentage of another

WORKED Example 7

2 Each of the following measurements are given to the nearest 10 m. State the limits between which the true length lies.

a 40 m **b** 90 m **c** 250 m
d 300 m **e** 1000 m **f** 2 km

EXCEL Spreadsheet Calculations with percentages

3 Each of the following measurements are given correct to 1 decimal place. State the limits between which the true length lies.

a 5.3 cm **b** 9.8 m **c** 7.2 km
d 5.0 mm **e** 9.9 km **f** 0.1 m

WORKED Example 8

4 The distance between two towns is given as 45 km, correct to the nearest kilometre.

a Between what two limits does the true distance lie?
b What is the greatest possible error in the distance?
c Write the degree of accuracy in this measurement as a percentage, correct to 2 decimal places.

5 For each of the following measurements, write the degree of accuracy as a percentage, correct to 2 decimal places.

a A person's mass is given as 67 kg, correct to the nearest kilogram.
b The capacity of a bucket is 7 L, correct to the nearest litre.
c The length of a park is said to be 180 m, correct to the nearest 10 m.
d The volume of water in a tank is 38.6 L, correct to 1 decimal place.
e The distance between Sydney and Melbourne is 1000 km, correct to the nearest 100 km.

6 a Measure each of the following lines to the nearest centimetre.

i _____
ii _____
iii _____

b For each, find the maximum percentage error in the measurement, correct to 2 decimal places.

7 a Measure each of the lines in question **6**, correct to the nearest millimetre.
b When the lines are measured correct to the nearest millimetre, what is the maximum percentage error for each line?

8 Janice estimates that it takes 1 hour and 20 minutes to drive to a friend's house.

a If Janice's estimate is to the nearest 10 minutes, between what two lengths of time does it take Janice to make the journey?
b What is the maximum error in Janice's estimate?
c Find the degree of accuracy of Janice's estimate, as a percentage, correct to 2 decimal places.

9 **multiple choice**

The length of a house, correct to 2 decimal places, is given as 19.95 m. Which of the following statements is the most accurate?

A The length of the house is between 19.9 m and 20 m.

B The length of the house is between 19.945 m and 19.955 m.

C The length of the house is between 19.94 m and 19.96 m.

D The length of the house is between 19.955 m and 20 m.

10 **multiple choice**

The world record for 100 m is 9.77 s. This is the time correct to 2 decimal places. What is the maximum possible error in this time?

A 0.5 s **B** 0.05 s **C** 0.005 s **D** 0.1 s

11 **multiple choice**

An aeroplane trip takes 17 hours, correct to the nearest hour. The degree of accuracy, correct to 2 decimal places, is:

A 0.29% **B** 1.76% **C** 2.94% **D** 5.88%

12 **multiple choice**

Which of the following four measurements has the greatest degree of accuracy?

A The mass of a bag of beans is 400 g, correct to the nearest 50 g.

B A water container contains 10 L of water, correct to the nearest litre.

C The distance from home to school is 1.6 km, correct to 1 decimal place.

D A roast is to cook for 1 hour and 30 min, correct to the nearest 5 minutes.

13 A paddock needs a fence which is 30 m long and 20 m wide, when measured to the nearest metre.

a Between what two measurements does the length lie?

b Between what two measurements does the width lie?

c What is the smallest possible length of fencing needed?

d What is the greatest possible length of fencing needed?

e What is the maximum error in the length of fencing needed?

14 For the paddock in question **13**, the area is found by multiplying the length by the width.

a By multiplying the smallest possible length and width, find the smallest possible area.

b By multiplying the largest possible length and width, find the largest possible area.

c What is the maximum error in the area of the paddock?

WORKED Example 9

15 The capacity of a jug is measured by 5 people to be 750 mL, 752 mL, 749 mL, 753 mL and 748 mL. Calculate the average of these 5 readings.

16 The distance between two towns is given on 4 different maps as 79 km, 81 km, 77 km and 80 km. Calculate the average of these 4 readings.

Measuring heights

In your class, get each person to measure the height of one class member. Each person writes down their reading, without showing it to anyone else. When all readings are taken, answer the following questions.

1. What unit did you use to measure height?
2. What is the maximum error?
3. Calculate the percentage error using your reading.
4. What was the smallest height measured?
5. What was the greatest height measured?
6. Calculate the average reading.

10 QUICK QUESTIONS 1

Convert the following measurements into the units indicated.

1. 450 cm (m)
2. 6.8 km (m)
3. 6800 g (kg)
4. 9.45 L (mL)
5. 4 min (s)
6. 3 days (h)
7. 5.6 m (cm)
8. 40 000 mm (cm)
9. The mass of a person is shown on a scale as 65.7 kg, correct to 1 decimal place. Between what two measurements does the person's mass lie?
10. The distance between two houses is given as 360 m, correct to the nearest 10 m. Find the degree of accuracy, correct to 1 decimal place.

Significant figures

Consider each of the following measurements.

- The distance from the Earth to the Sun is 149 000 000 km.
- The distance between Sydney and Melbourne is 1040 km.
- A circle with a radius of 5 cm has an area of 78.54 cm^2.

In each of the above cases the measurement is not exactly correct. As already stated, all measurements are approximations. Each of these measurements has had a sensible and practical approximation applied.

- The distance from the Earth to the Sun has been given to the nearest one million kilometres. The distance to the nearest kilometre is needed only for very precise scientific work.
- The distance between Sydney and Melbourne is given to the nearest kilometre. No-one travelling between these two cities would need to know the distance with any greater degree of accuracy.
- Using the formula $A = \pi r^2$ the calculator gives the area of the circle as 78.539 816 34. Using 2 decimal places is usually a more practical way to answer such questions.

The accuracy of every measurement taken is limited by the accuracy of the instrument used to take the measurement. The measurement is then given to the most practical degree of accuracy.

Measurements are usually given to a required number of significant figures. In the examples above:

- 149 000 000 km is to 3 significant figures
- 1024 km is to 4 significant figures
- 78.54 cm^2 is also to 4 significant figures.

Significant figures are the number of non-zero digits at the beginning of a number. The zeros that fill the remaining places are not significant and are there to maintain the correct place values. (*Note:* Zeros between 2 significant figures are taken to be significant, for example, 1024 has 4 significant figures, not 3.) Consider the situation below.

A star is a distance of 68.04 light-years away from the Earth. If the speed of light is 299 792 km/s and a year is taken to be 365.26 days, what is the distance from the Earth to the star, in kilometres?

A light-year is the distance that light will travel in 1 year. Therefore:

$$\begin{aligned} 1 \text{ light-year} &= 299\,792 \times 60 \times 60 \times 24 \times 365.26 \\ &= 9\,460\,975\,039\,488 \text{ km} \end{aligned}$$

$$\begin{aligned} \text{Distance} &= 68.04 \times 9\,460\,975\,039\,488 \\ &= 643\,724\,741\,686\,764 \text{ km} \end{aligned}$$

With such large numbers it is not usually necessary to be so exact. We could say that the distance was approximately 644 000 000 000 000 km. In this example we have rounded the distance off, correct to 3 significant figures.

In this example, the zeros are not significant figures. When rounding off, however, we must include them, so that each significant figure has its correct place value.

When rounding a number off to 3 significant figures, we cut the number off after the first three non-zero digits and round off using the same rules as for decimal places. We then fill out the remaining places with zeros.

WORKED Example 10

Round each of the following numbers off to the required number of significant figures.
a 25 854 789 652 (2 significant figures)
b 63 879 258 (1 significant figure)

THINK	WRITE
a 1 Rounding off to 2 significant figures, so we look at the third significant figure.	a
2 This digit is 8, so take the second significant figure up by 1 and fill out the remaining places with zeros.	26 000 000 000
b 1 Rounding off to 1 significant figure, so we look at the second significant figure.	b
2 This digit is 3, so it is ignored and the remaining places are filled out with zeros.	60 000 000

Significant figures can also be used to round off decimals. Care must be taken when reading a question to see if you are being asked to round off using significant figures or decimal places. Zeros at the front of a decimal are not considered to be significant figures. For the decimal 0.000 254 878 the first significant figure is the 2. If we round off to 2 significant figures $0.000\,254\,878 \approx 0.000\,25$.

When rounding off decimals to a set number of significant figures, the zeros at the front must be left in place but there is no need to fill out remaining places with zeros.

WORKED Example 11

Round each of the following numbers off to the number of significant figures indicated.
a 0.005 254 8 (3 significant figures)
b 0.014 725 8 (2 significant figures)

THINK	WRITE
a 1 Rounding off to 3 significant figures, so we look at the fourth significant figure.	a
2 This digit is 4, so it and the following digits are ignored.	0.005 25
b 1 Rounding off to 2 significant figures, so we look to the third significant figure.	b
2 This digit is 7, so the second significant figure must be increased by 1.	0.015

For very large or very small numbers we use significant figures together with scientific notation. If you look up in the sky at night, the closest star you can see is approximately 41 600 000 000 000 kilometres away.

This measurement has been given correct to 3 significant figures. It can also be written as 4.16×10^{13} km, which is in scientific notation correct to 3 significant figures.

41 600 000 000 000 = 4.16×10^{13} and is entered as 4.16 EXP 13. The appearance of this on the calculator display will vary with different types of calculators.

An example of a very small measurement is the width of a human hair. This may be 0.000 000 041 365 mm. In scientific notation, correct to 2 significant figures, we would write this as 4.1×10^{-8} mm.

WORKED Example 12

Write each of the following measurements in scientific notation, correct to 3 significant figures.

a 25 473 269 000 km **b** 0.000 004 583 12 g **c** 499.85 L

THINK	WRITE
a 1 Look at the fourth significant figure. 2 This digit is a 7, so the third significant figure must be increased by 1. 3 The decimal place must be moved 10 places left to be between the first 2 significant figures.	**a** 2.55×10^{10}
b 1 Look at the fourth significant figure. 2 This digit is a 3, so it and the following digits are ignored. 3 The decimal place must be moved 6 places right to be between the first 2 significant figures.	**b** 4.58×10^{-6}
c 1 Look at the fourth significant figure. 2 This digit is an 8, so the third significant figure must be increased by 1. As this digit is a 9, the previous digit must be increased until a number other than 9 is reached. 3 The decimal place must be moved 2 places left to be between the first 2 significant figures.	**c** 5.00×10^{2}

remember

1. A measurement is usually given to a required number of significant figures.
2. We round off using significant figures by counting the first non-zero digits. The same rules are used to round off significant figures as for decimal places. However, with significant figures zeros must be used to fill places to make sure all digits have the same place value.
3. Very large or very small measurements are written in scientific notation, correct to a required number of significant figures.

EXERCISE 2C Significant figures

SKILLSHEET 2.4 Rounding to a given number of decimal places

WORKED Example 10

1 Round each of the following off to the number of significant figures indicated.

a 24 587 258 (2) **b** 236 500 258 (1)
c 8 782 568 (3) **d** 4587 (1)
e 654 200 (1) **f** 287.35 (3)

WORKED Example 11

2 Round each of the following off to the number of significant figures indicated.

a 0.032 579 81 (2) **b** 0.003 658 (1)
c 0.001 498 758 (3) **d** 6.256 677 158 (4)
e 68.254 (3) **f** 0.000 201 47 (1)

3 Write the distance 146 565 992 km correct to:

a 1 significant figure **b** 2 significant figures
c 3 significant figures **d** 5 significant figures.

4 **multiple choice**

When rounded to 2 significant figures, 0.035 81 is equal to:

A 0.03 **B** 0.04 **C** 0.035 **D** 0.036

5 **multiple choice**

The distance between two cities is 2986 km. Rounded to 2 significant figures, this distance becomes:

A 29 km **B** 2900 km **C** 2986.00 km **D** 3000 km

6 **multiple choice**

45.5698 = 45.57 when it is rounded to which degree of accuracy?

A 2 decimal places **B** 4 significant figures
C Both A and B **D** Neither A nor B

WORKED Example 12

7 Write each of the following measurements in scientific notation, correct to 2 significant figures.

a 471 591 400 km **b** 7 415 200 000 000 mm **c** 12 850 t
d 0.002 369 g **e** 0.222 221 L **f** 0.002 99 s

8 The distance between the planet Mars and the Sun is given by the *World Book Encyclopedia* as 227 900 000 km.

a Do you think this answer is correct to the nearest kilometre? Explain your answer.

b To how many significant figures has this distance been given?

c Give this distance correct to 2 significant figures.

9 Copy and complete each of the following measurement conversions.

a 2.4×10^6 mm = ____ m

b 9.1×10^8 m = ____ km

c 4.6×10^6 cm = ____ mm

d 4.9×10^5 kg = ____ t

e 3.45×10^7 t = ____ kg

f 8.11×10^6 kg = ____ g

g 8.9×10^7 L = ____ kL

h 1.09×10^{10} kL = ____ L

i 7.1×10^3 L = ____ mL

10 Scientists in a laboratory measure the diameter of a certain microbe to be 0.000 000 2 mm, and growing by 0.000 000 000 5 mm/day. What will be the diameter of the microbe in 10 days? (Answer in scientific notation.)

11 A light-year is defined as the distance travelled by light in one year. If light travels at 2.991×10^5 km/s, calculate in scientific notation the size of a light-year, correct to 3 significant figures. (1 year = 365.26 days)

Rates

It is the last day of a test cricket match between Australia and India. To win the match, Australia need to make 280 runs in 80 overs. How many runs per over do they need to score?

This question requires us to work with **rates**. A rate is a comparison of two quantities of a different type. In this example we need to compare runs with overs.

WORKED Example 13

What quantities are being compared in each of the following rates?
a 60 km/h b $2.50/kg c 1500 kL/year

THINK	WRITE
a A kilometre is a measure of distance. An hour is a measure of time.	**a** 60 km/h compares distance with time.
b $2.50 is an amount of money. Kilograms is a measure of mass.	**b** $2.50/kg compares money with mass.
c A kilolitre is a measure of capacity. Years are a measure of time.	**c** 1500 kL/year compares capacity with time.

Rates, like ratios, often need to be simplified. To simplify a rate, we divide the first quantity by the second quantity. A rate is always simplified to a single unit.

WORKED Example 14

Simplify each of the following rates fully.
a 240 km in 3 hours b $29.96 for 40 litres c 280 runs in 80 overs

THINK	WRITE
a 1 Rewrite the original rate. 2 Divide the first quantity by the second quantity. (240 ÷ 3) 3 Write the answer as a simplified rate.	**a** 240 km in 3 hours = 80 km in 1 hour = 80 km/h
b 1 Rewrite the original rate. 2 Divide the first quantity by the second quantity. (29.96 ÷ 40) 3 Write the answer as a simplified rate.	**b** $29.96 for 40 litres = $0.749 for 1 litre = 74.9 c/L
c 1 Rewrite the original rate. 2 Divide the first quantity by the second quantity. (280 ÷ 80) 3 Write the answer as a simplified rate.	**c** 280 runs in 80 overs = 3.5 runs in 1 over = 3.5 runs/over

Once we are able to simplify rates, we can use them to solve problems. Solving problems usually involves multiplying or dividing quantities and rates. In each example, we need to carefully think about which of these we need to do and clearly set out the working steps.

WORKED Example 15

Giovanni is a plumber who charges $22.50/h for labour. What will be his labour charge for a job that takes 4 hours?

THINK	WRITE
1 $22.50 for 1 hour, so multiply by 4 to calculate the labour charge.	$\$22.50 \times 4 = \$90.00$
2 Give a written answer.	Giovanni charges $90.00 for 4 hours labour.

A common example of where a rate must be used is when modifying a recipe for a set number of people. A recipe may be given to serve 4 people but we may need to modify it to serve, say, 6. In such a case, each ingredient would need to be multiplied by $1\frac{1}{2}$.

WORKED Example 16

Below are the ingredients to make a banana pudding for 6 people.

4 bananas	**10 mL lemon juice**	**2 eggs**
20 g castor sugar	**250 g coconut**	**20 g apricot jam**

Janice is having 9 people to dinner. Modify this recipe to serve 9.

THINK	WRITE
1 Divide 9 by 6 to calculate the multiplication factor.	Multiplication factor $= 9 \div 6 = 1\frac{1}{2}$
2 Multiply each ingredient by $1\frac{1}{2}$.	bananas $= 4 \times 1\frac{1}{2} = 6$ eggs $= 2 \times 1\frac{1}{2} = 3$ coconut $= 250\text{ g} \times 1\frac{1}{2} = 375\text{ g}$ lemon juice $= 10\text{ mL} \times 1\frac{1}{2} = 15\text{ mL}$ castor sugar $= 20\text{ g} \times 1\frac{1}{2} = 30\text{ g}$ apricot jam $= 20\text{ g} \times 1\frac{1}{2} = 30\text{ g}$

In a few examples a rate can compare two measurements of the same type. For example, a concentration of medicine may contain a mass/weight rate or a mass/volume rate. This is where we are measuring the **concentration** of a certain substance. The concentration is the amount of one substance that is contained within another.

WORKED Example 17

The concentration of pentoxyverine citrate in a cough mixture is 15 mg/100 mL. A person should not consume more than 9 mg of pentoxyverine citrate per day. If one dose of the cough medicine is 10 mL, what is the maximum number of doses a person can have per day?

THINK	WRITE
1 Calculate the amount of pentoxyverine citrate in one dose of cough mixture.	1 dose = 10 mL, so 100 mL = 10 doses 15 mg of pentoxyverine in 100 mL of cough mixture means 15 mg of pentoxyverine citrate in 10 doses or 1.5 mg of pentoxyverine citrate in 1 dose.
2 Divide the maximum amount of pentoxyverine citrate that can be consumed per day by the amount in each dose.	$9 \div 1.5 = 6$
3 Give a written answer.	A person can have a maximum of 6 doses of cough mixture per day.

We need to be able to use the conversion facts for measurement to convert between rates. We should be able to convert km/h to m/s and other similar rates. This is done by changing each unit separately at each stage of the conversion while keeping the equivalent rate.

WORKED Example 18

Convert the speed 20 m/s into km/h.

THINK	WRITE
1 Convert 20 m/s to m/min by multiplying by 60.	20 m/s = 1200 m/min
2 Convert 1200 m/min to m/h by multiplying by 60.	= 72 000 m/h
3 Convert 72 000 m/h to km/h by dividing by 1000.	= 72 km/h

remember

1. A rate is a comparison of two quantities of a different type.
2. To simplify a rate, we compare the first quantity with one unit of the second quantity.
3. Rate questions need to be read carefully to see whether to multiply or divide to solve the problem.
4. Rates are converted by changing each unit separately, at each stage writing the equivalent rate.

EXERCISE 2D Rates

WORKED Example 13

1 What quantities are being compared in each of the following rates?

a 80 km/h	**b** $2.50/kg	**c** $12.40/h
d 50 g/L	**e** 4 goals/game	**f** 2°C/min
g 5.1 m/s	**h** 200 g/m^2	**i** 78.9 c/L
j 6 s/kg	**k** 40 L/100 km	**l** 2 m/year

WORKED Example 14

2 Simplify each of the following rates (where necessary answer to 1 decimal place).

a 270 km in 3 hours	**b** $32 for 8 kg	**c** 250 runs in 50 overs
d 10 degrees in 2 h	**e** $65 for 4 h	**f** 90 m^2 with 4 kg
g 600 m in 80 s	**h** $223 in 5 days	**i** 500 km on 65 L
j 23 goals in 8 games	**k** 400 kL for 32 days	**l** $42.68 for 55 L

3 multiple choice

George buys 600 g of bacon at the delicatessen for $5.94. As a rate this is equal to:

A $3.56/kg **B** 99 c/kg **C** $9.90/kg **D** $35.64/kg

4 Josie takes her car to the mechanic for a service. The mechanic worked on the car and charged Josie $68.50 for $2\frac{1}{2}$ hours labour. At what rate has she been charged for labour?

5 After 15 minutes of hard exercise, Roula's heart beat 520 times in the next 4 minutes. What is her heart rate in beats per minute?

6 Judy wants to leave Melbourne at 6:00 am bound for Sydney, a distance of 1040 km. She needs to be in Sydney by 8:00 pm that evening. If she allows for 2 hours as rest breaks, what speed must she average to arrive in time? (Answer to the nearest whole number.)

7 The race record for the Melbourne Cup is 3 min 16.9 s held by Kingston Rule. The Melbourne Cup is run over 3200 m.

a How many seconds did Kingston Rule take?

b What was the average speed of Kingston Rule in metres per second, to 1 decimal place?

8 Kristel's car is filled with petrol. After travelling 345.6 km she found that her car had used 48 L of petrol. What was the fuel consumption of Kristel's car in km/L?

9 More commonly, fuel consumption is expressed in L/100 km. A car travels 400 km on 48 L of petrol. What would be the fuel consumption in L/100 km?

10 multiple choice

Hugo's car used 56 litres of petrol on a trip of 400 km.
Statement 1: Hugo's fuel consumption is 7.14 km/L, correct to 2 decimal places.
Statement 2: Hugo's fuel consumption is 14 L/100 km.
Which of the above statements is true?

A 1 only **B** 2 only **C** Both 1 and 2 **D** Neither 1 nor 2

WORKED Example 15

11 Jodie is paid $11.23 per hour for her job at the bank. How much does she earn in a week if she works 42 hours?

12 A patient in hospital is placed on an intravenous drip. The medication is given to the patient at a rate of 15 drips/min. Each drip is 0.25 mL. How much medication will the patient receive in 4 hours?

WORKED Example 16

13 Below are the ingredients for seafood mornay.

600 g of rice	300 g of pink salmon	1 egg
60 g of butter	30 g of plain flour	450 mL of milk
90 g of shredded cheese	75 g of breadcrumbs	

This recipe serves 6 people. Modify the recipe so that it will serve 8 people.

14 The ingredients below make 15 chocolate cookies.

300 g of brown sugar	90 g of oil	30 g of cocoa powder
120 g of self-raising flour	120 g of plain flour	90 g of choc bits
60 g of white chocolate		

Modify the recipe to make 10 chocolate cookies.

WORKED Example 17

15 A sore throat treatment contains 7.5 g/100 mL of povidone. If the intake of povidone must not exceed 3 grams per day and each dose of the sore throat treatment is 5 mL, calculate the maximum number of doses a person can take each day.

16 A dietary supplement for cattle requires that the bull be fed 2.5 g/kg weight. Calculate the amount of the dietary supplement required for a 760 kg bull.

17 In his job as a sales assistant Jacob is paid $9.60 per hour.

a On Saturdays he is paid at a rate of time and a half. How much does he receive each hour for working on Saturday?

b How much does Jacob earn on a Saturday if he starts work at 8:00 am and finishes at 1:00 pm?

EXCEL Spreadsheet Speed converter

WORKED Example 18

18 Convert a speed of 15 m/s to km/h.

19 Convert each of the following rates.

a 90 km/h to m/s

b 2.5 m/s to km/h

c 8 mL/m to L/km

d 8 km/L to L/100 km

20 multiple choice

Which of the following is the most economical fuel consumption?

A 10 km/L **B** 10 L/100 km **C** 12 km/L **D** 12 L/100 km

21 The instructions on a 1 kg bag of lawn food say to use 125 g/m^2 of lawn. Nora buys 5 bags of the lawn food. Does she have enough to do a lawn that is 43 m^2 in area? Explain your answer.

22 A car uses 45 L of petrol on a 432 km trip.

a Write the fuel consumption in km/L.

b How much fuel will the car use on a 324 km trip at the same rate?

Percentage change

You should be familiar with increasing and decreasing an amount by a percentage. We will now examine consecutive percentage changes.

Consider the case of a pair of rollerblades that is usually priced at $120. The price rises by 20% but then a discount of 20% is applied. The price does not revert to $120 because the increase and decrease are 20% of different amounts.

WORKED Example 19

The price of a pair of rollerblades is $120. The price is increased by 20% and then decreased by 20%. Calculate the new price of the rollerblades.

THINK	WRITE
1 Increase $120 by 20%.	120% of $120 = 120 ÷ 100 × $120 = $144
2 Decrease $144 by 20%.	80% of $144 = 80 ÷ 100 × $144 = $115.20

remember

1. When we increase and decrease a quantity by the same percentage, the quantity does not revert to the original amount.
2. The increase and the decrease need to be calculated separately.

EXERCISE 2E Percentage change

SKILLSHEET 2.5 Increase or decrease by a percentage

WORKED Example 19

1 The cost of a stereo system is $750. The price is increased by 10% and then decreased by 10%. Calculate the new price of the stereo.

2 Calculate each of the following.
- **a** Increase 25 km by 5% and decrease the result by 5%.
- **b** Decrease 560 kg by 15% and then increase the result by 15%.
- **c** Increase 4 hours by 40% and then decrease the result by 40%.

3 The time taken to travel between two towns is 2 hours. A new section of road decreases the travelling time by 5%.
- **a** Calculate the new travelling time between the two towns.
- **b** An accident then increases the travelling time on a particular day by 20%. Calculate the time taken to travel between the two towns.

4 Increase $150 by 10% and then increase the result by 10%.

5 Decrease 250 kg by 5% and then decrease the result by 5%.

6 Are each of the following calculations equal?
- **a** 50 litres is increased by 10% and then the result is increased by 20%.
- **b** 50 litres is increased by 20% and then the result is increased by 10%.

7 A carpenter purchases $600 worth of items from a hardware store. He receives a 5% discount for paying cash and a further 2.5% trade discount. Calculate what he pays for the items.

8 The price of a $200 tool kit is increased by 25%.
- **a** Calculate the new price of the tool kit.
- **b** The price of the tool kit is then reduced back to $200 during a sale. Calculate the percentage discount that has been applied.

10 QUICK QUESTIONS 2

1 Copy and complete the following: 5.46 m = ____ cm.

2 The mass of a horse is found to be 725 kg, correct to the nearest kilogram. Within what range could the actual mass of the horse lie?

3 Calculate the maximum percentage error in the weight of the horse, correct to 3 decimal places.

4 Write 0.028 34 cm correct to 2 significant figures.

5 Write 178 569 543 in scientific notation correct to 3 significant figures.

6 Write 0.000 001 011 03 in scientific notation correct to 2 significant figures.

7 Simplify the rate 45 kg in 3 hours.

8 Convert the speed 56 km/h to m/s, correct to 1 decimal place.

9 Increase $280 by 10% and decrease the result by 5%.

10 Decrease $13.50 by 20% and then increase the result by 20%.

Using ratios

Zhong and Hasam invest money in a business. Zhong invests $25 000 and Hasam invests $30 000. The business made a profit of $33 000 in the first year. If their profit is to be fairly shared, how much should each of the partners receive? We need a simple method for comparing the investment of each partner. We do this by using **ratios**.

A ratio is a comparison of two or more quantities measured in the same units. For example, a ratio can be used to compare two quantities of money in dollars, two distances in kilometres or two masses in grams. However, we can't use a ratio to compare quantities of different types. For example, a ratio can't compare a distance with a mass.

A ratio can be simplified by dividing each quantity by the highest common factor (HCF). When this is done, we say the ratio has been fully simplified. The ratio is then easier to use in solving problems.

WORKED Example 20

Fully simplify the following ratios.
a 24 cm : 32 cm **b** \$3.60 : \$2.10 **c** 3 m : 80 cm

THINK

a 1 Write down the question, ignoring units.
2 Divide both numbers by the HCF (8).
b 1 Write down the question.
2 Write both money quantities as cents.
3 Divide by the HCF (30).
c 1 Write the question.
2 Change metres to centimetres.
3 Divide by the HCF (20).

WRITE

a 24 : 32
3 : 4
b \$3.60 : \$2.10
360 : 210
12 : 7
c 3 m : 80 cm
300 : 80
15 : 4

Once we are able to write ratios, we can use them to compare quantities. We do this by comparing the two parts of the ratio. We can consider each part of the ratio as consisting of a number of shares. If we know the value of one part of the ratio we can find the value of one share and hence find the other part of the ratio. This is known as the **unitary method**.

WORKED Example 21

Jane and Brooke's heights are in the ratio 9 : 10. If Jane is 162 cm tall, how tall is Brooke?

THINK

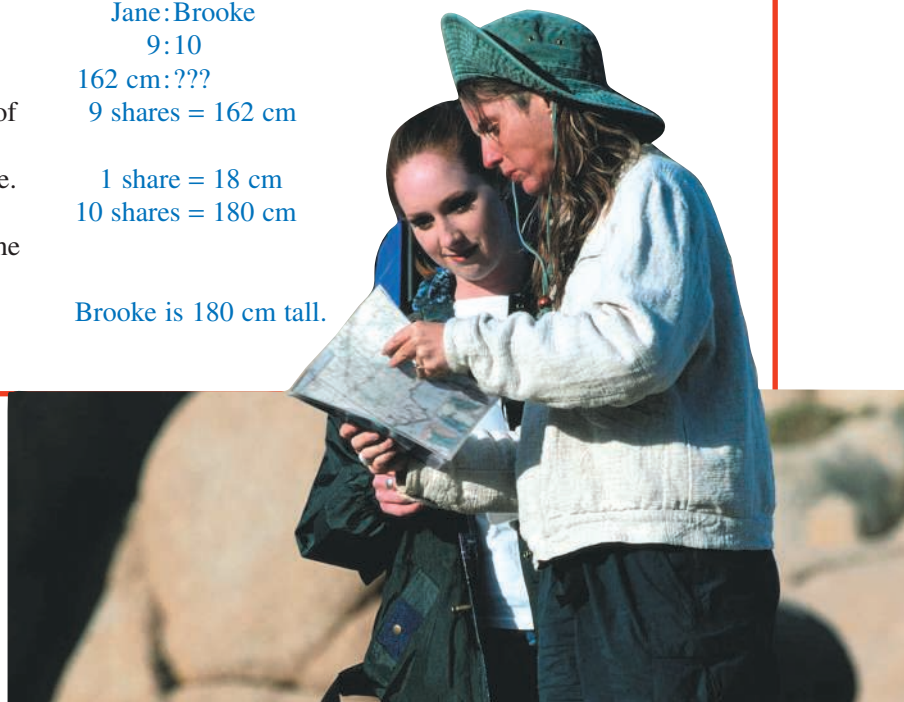
1 Model the problem by comparing the ratio to the known information.
2 Compare the known part of the ratio (Jane's height).
3 Divide by 9 to find 1 share.
4 Multiply 1 share by 10 to find the unknown part of the ratio.
5 Give a written answer.

WRITE

Jane : Brooke
9 : 10
162 cm : ???
9 shares = 162 cm

1 share = 18 cm
10 shares = 180 cm

Brooke is 180 cm tall.



Returning to the problem at the start of this section, we can use ratios to divide a quantity into unequal parts.

WORKED Example 22

Zhong and Hasam invest money in a business. Zhong invests $25 000 and Hasam invests $30 000.

a What is the ratio of these investments?

b If the business makes a profit of $33 000 in the first year, how much should each of the partners receive?

THINK

a
1. Write down the whole ratio.
2. Divide by the HCF (5000).

b
1. Sum the parts and make this equal to $33 000.
2. Divide $33 000 by 11 to find 1 share.
3. Zhong receives 5 shares so multiply 1 share by 5.
4. Hasam receives 6 shares so multiply 1 share by 6.
5. Give a written answer.

WRITE

a $25 000 : $30 000
5 : 6

b 11 shares = $33 000

1 share = $3000
5 shares = $15 000

6 shares = $18 000

Zhong's share is $15 000 and Hasam's share is $18 000.

remember

1. A ratio is a comparison of two quantities of the same type.
2. To be compared, both quantities need to be in the same unit.
3. Ratios can be simplified by dividing each part by the highest common factor (HCF).
4. To divide a quantity in a given ratio, we calculate the value of one share before calculating each part of the ratio.
5. To do most ratio problems you will need to know your basic measurement facts.

EXERCISE 2F Using ratios

SKILLSHEET 2.6 Simplifying ratios

EXCEL Spreadsheet Ratios

WORKED Example 20

1 Fully simplify each of the following ratios.

a \$20:\$4	**b** 50 cm:45 cm	**c** 300 g:800 g
d 560 km:240 km	**e** 35 t:21 t	**f** 375 mL:500 mL
g 15c:80c	**h** 4 weeks:52 weeks	**i** 800 mm:550 mm
j 1250 mL:300 mL	**k** 80 cm:1 m	**l** \$1:60c
m 1 kg:250 g	**n** 400 mL:1 L	**o** 40 min:1 h
p \$4:20c	**q** 750 kg:2 t	**r** 900 L:3 kL
s 3 min:45 s	**t** 600 g:10 kg	**u** 1.25 L:500 mL
v \$10:\$6.50	**w** 3.6 km:800 m	**x** 3 t:450 kg

2 multiple choice

The ratio 3 h:45 min fully simplified is:

A 3:45 **B** 1:15 **C** 180:45 **D** 4:1

3 multiple choice

The ratio 80 cm:2 km fully simplified is:

A 40:1 **B** 1:2500 **C** 2:5 **D** 1:125

WORKED Example 21

4 The ratio of boys to girls in a class is 5:4. If there are 15 boys in the class, how many girls are there?

5 In a school, the ratio of students to teachers is 35:2. If the school has 60 teachers, how many students attend the school?

6 The ratio of the weight of a male elephant to a female elephant is 10:9. If the male elephant weighs 1400 kg, what does the female elephant weigh?

7 In a cordial mixture, the ratio of syrup to water is 2:15.

a How much water must be added to a 1 litre bottle of syrup?

b How much cordial will this mixture make?

8 In a cricket match, the ratio of Australia's score to England's score is 5:3. If England made 192 runs, how many did Australia make?

9 In Parliament, the ratio of Liberal members to Labor members is 4:3. If there are 63 Labor members of the Parliament, how many Liberal members are there?

10 multiple choice

In her yearly exams, the ratio of Rita's Maths mark to her English mark was 8:7. If she scored 56% in English, what did she score in Maths?

A 49% **B** 63% **C** 64% **D** 72%

11 Tom and Rachael divide \$1000 in the ratio 7:3. How much should each receive?

12 Natalie and Kathy share a job in the ratio 3:2. If their job is a 35 hour per week job, how many hours does each person work?

13 In a game of netball a team scored 45 goals. The goals were scored by the goal shooter and the goal attack in the ratio 7:2. How many goals were scored by the goal attack?

14 A game of AFL at the Telstra Stadium attracts a crowd of 80 000 people. The ratio of Sydney supporters to Collingwood supporters is 11:5. How many Collingwood supporters are at the game?

15 **multiple choice**

A fruit punch drink is to be made for a party. It consists of orange juice, pineapple juice and apple juice in the ratio 5:3:2. If we want to fill a 9 litre bucket with the punch, how much pineapple juice will be needed?

A 0.9 L **B** 2.7 L **C** 3 L **D** 5 L

16 A radio station plays 14 songs in one hour. Of these, 4 are by Australian artists.

a What is the ratio of Australian music to overseas music played during this hour?

b If during a week this ratio is maintained, how many tracks by Australian artists will be played if a total of 2100 tracks are played?

WORKED Example 22

17 Sandra and Kevin purchase a Lotto entry. The entry costs $24.80. Sandra puts in $15.50 and Kevin the rest.

a How much does Kevin put towards the cost of the Lotto entry?

b What is the ratio of their contributions?

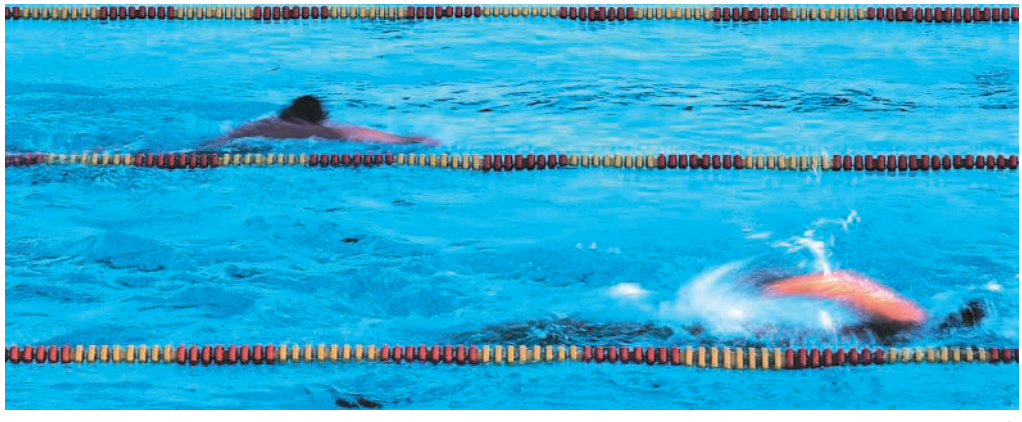
c If the entry wins a prize of $640 000 and they agree to share the winnings in the same ratio as their contributions, how much should each receive?

18 A concrete mix is made from sand, cement and gravel in the ratio 3:2:1. How much of each component will be needed to make 150 kg of concrete?

19 At the Commonwealth Games, Australia won 60 gold, 75 silver and 30 bronze medals.

a Simplify the ratio of gold:silver:bronze medals.

b If at the Olympic Games medals were won in the same ratio, how many gold medals would be won if Australia won a total of 33 medals?



20 Monica and Vicky share a two bedroom flat. Monica's bedroom has an area of 15 m^2, while Vicky's has an area of 12 m^2.

a What is the ratio of the area of Vicky's bedroom to Monica's?

b The rent on this flat is $180 per week and they agree that the rent should be split in the ratio of their bedroom areas. How much should they each contribute to the rent?

WORKSHEET 2.2

summary

Units of measurement

- Measures of length: 10 mm = 1 cm, 100 cm = 1 m, 1000 m = 1 km
- Measures of mass: 1000 g = 1 kg, 1000 kg = 1 t
- Measures of capacity: 1000 mL = 1 L, 1000 L = 1 kL

Relative error

- All measurements are approximations.
- Every measuring instrument is limited in the degree of accuracy that it allows.
- The maximum error is half the degree of accuracy used.
- A true gauge of the accuracy of a measurement is to calculate the maximum error as a percentage of the measurement we have taken.

Scientific notation

- Scientific notation is a method for writing very large and very small measurements.
- For numbers greater than one, we move the decimal point between the first two digits and multiply by the power of 10 corresponding to the number of places the decimal point has moved to the left.
- For positive numbers less than one, we move the decimal point between the first two non-zero digits and multiply by the negative power of 10 corresponding to the number of places the decimal point has moved to the right.

Rates

- A rate is a comparison of two quantities of different types.
- To simplify a rate, we compare the first quantity with one unit of the second quantity.
- Many problems involve using rates and these questions must be read carefully to determine whether to multiply or divide to solve the problem.

Percentage change

- Percentage change involves increasing or decreasing an amount by a percentage.
- When more than one percentage change is to be done, each must be carried out separately.

Ratios

- A ratio is a comparison of two quantities of the same type.
- Ratios often need to be simplified, and this is done by dividing each part by the highest common factor.
- When a quantity needs to be divided in a given ratio, we add the parts of the ratio to find the total number of shares, then divide the quantity by this number to find the value of one share. Each part of the ratio can then be calculated by multiplying this by the number of shares in each part.

CHAPTER review

1 Copy and complete each of the following. 2A

a 90 mm = ____ cm **b** 6 m = ____ cm **c** 6.7 km = ____ m
d 4800 m = ____ km **e** 6.9 cm = ____ mm **f** 11.25 m = ____ cm
g 9000 g = ____ kg **h** 9500 kg = ____ t **i** 4.84 kg = ____ g
j 11 000 L = ____ kL **k** 4550 mL = ____ L **l** 12.8 L = ____ mL
m 300 s = ____ min **n** 240 min = ____ h **o** 96 h = ____ days
p 4 days = ____ h **q** 4 years = ____ days **r** 5 years = ____ months

2 An elevator has a capacity of 1.3 tonnes. If 18 people who each weigh an average of 66 kg are on the elevator, how much under the capacity is the total weight? 2A

3 In each of the following, a measurement and its degree of accuracy are given. State the limits between which the measurement lies. 2B

a 34 cm, correct to the nearest centimetre
b 8.9 kg, correct to 1 decimal place
c 500 km, correct to the nearest 100 km
d 2.25 L, correct to 2 decimal places
e 800 km, correct to the nearest 10 km

4 For each of the measurements in question **3**, find the degree of accuracy as a percentage, correct to 1 decimal place. 2B

5 Write each of the following measurements in scientific notation. 2C

a 60 000 000 km **b** 400 000 mm **c** 147 000 000 m
d 643 000 t **e** 0.8739 t **f** 0.000 574 g
g 0.002 874 mL **h** 0.005 874 g

6 Copy and complete each of the following. 2C

a 5.2×10^5 cm = ____ mm **b** 9.1×10^7 g = ____ kg **c** 3.45×10^7 t = ____ kg

7 Simplify each of the following rates. 2D

a \$2.50 for 10 L **b** 80 km in 2 h **c** \$42 for 5 h
d 3 h for 2 kg

8 A car is travelling at 90 km/h. How far will it travel in 7 hours at this rate? 2D

9 Eric earns \$12.45/h. How many hours does he need to work to earn more than \$400? 2D

10 If petrol costs \$1.27/L, how much petrol can be bought for \$40? 2D

11 The cost of a refrigerator is \$900. The price is then increased by the manufacturer by 10%. When on sale, the refrigerator is sold at a discount of 10%. Calculate the sale price of the refrigerator. 2E

12 Simplify each of the following ratios. 2F

a 9:12 **b** 64:48 **c** 90 m:150 m
d 40 min:25 min **e** \$5:80c **f** 500 m:3 km
g 40 min:3 h **h** 600 g:2 kg

2F

13 Jane and Allan share an amount of money in the ratio 5:3. If Jane's share of the money is $600, what is Allan's share?

2F

14 Divide $2000 in the ratio 3:7.

2F

15 Yasmin and Carrie purchase a lottery ticket for $5. Yasmin paid $3.50 and Carrie paid $1.50 for the ticket.
- **a** What is the ratio of their investments in the ticket?
- **b** If the ticket won $250 000, how much should each receive?

Practice examination questions

1 multiple choice

One litre of water has a mass of 1 kg. What would be the mass of 1 mL of water?

A 1 g **B** 10 g **C** 100 g **D** unknown

2 multiple choice

A tree's height is measured to be 17.3 m, correct to 1 decimal place. The maximum percentage error in the measurement of the tree is:

A 0.3% **B** 1.7% **C** 2.9% **D** 17%

3 multiple choice

The diameter of a human hair is 0.000 045 6 mm. In scientific notation this is equal to:

A 4.56×10^{-4} **B** 4.56×10^{-5} **C** 4.56×10^{4} **D** 4.56×10^{5}

4 multiple choice

Which of the following is the greatest speed?

A 100 km/h **B** 30 m/s **C** 1.5 km/min **D** 2500 km/day

5 multiple choice

The ratio of a tree's height to its girth is 15:4. If the height of the tree is 26.25 m, the girth is:

A 1.75 m **B** 6.5625 m **C** 7 m **D** 98.4375 m

6 On a set of building plans the length of a rectangular house is given as 20 500 mm.
- **a** State this length in metres.
- **b** Daryl measures the length of the house in metres, correct to 1 decimal place. State the maximum error of his measurement in millimetres.
- **c** Calculate the maximum percentage error in Daryl's measurement.
- **d** The width of the house is given as 8000 mm. Daryl calculates the area of the house as 164 000 000 mm^2. Give this measurement in scientific notation.

7 At a certain point in the orbit of the planets Earth and Mars, the distance for a spacecraft to travel from Earth to Mars is 55 750 450 km.
- **a** Give this distance correct to 3 significant figures.
- **b** Calculate the percentage error when the distance is rounded to 3 significant figures. Give the percentage error correct to 1 significant figure.
- **c** The spacecraft takes 2 years to travel to Mars. Calculate the speed of the spacecraft in kilometres per hour, correct to 2 significant figures.

test yourself CHAPTER 2